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should improve the designs of machines now being built. The best dimensions to give the different parts of any dynamo is a perfectly definite problem, involving, besides questions of electrical efficiency, questions of the cost of the iron and wire and labor. However, the problem can be solved, and each maker of dynamos should have it solved. In a recent paper, Professors Ayrton and Perry have considered the magnetic circuit of dynamo machines, and have arrived at some important conclusions. Considering the resistance of the magnetic circuit, they find, that, when a machine is working at its best permanent output, its iron magnetic resistance plus the air magnetic resistance of the clearance is equal to the air magnetic resistance of the space on the outside of the armature occupied by the winding. The paper of Professors Ayrton and Perry, with those above mentioned, will greatly aid in the improvement of dynamo-electric machinery.

MENTAL SCIENCE.

The Relative Legibility of the Small Letters.

READING is one of the most widespread of modern activities, and the endless multiplication of books and cheap editions makes a study of the factors of this process of great importance. In the end the process reduces to the differentiation of black or colored marks on a white or colored surface. 'Black on white' is current as an expression for clearness, leaving the question of the shapes of the letters as the important one. Inasmuch as the Roman alphabet is in use for the chief languages of civilization, and a large majority of the characters are formed by the small letters, the investigation of the forms of these letters is naturally the point of prime value. If by any means we can make the reading of these letters an easier task, the improvement, however minute, when multiplied by the number of times the letter is read, will be very great. This is, however, not the only consideration. Tint and quality of paper, length of lines and spaces between them, the size of the letters and their distances from one another,—all affect the legibility. The end to be aimed at is to attain "the greatest legibility to the square inch," with due regard to taste and economy. The solution of this problem has been experimentally attempted by Dr. Javal and by Dr. Cattell, and has recently been again studied with improved apparatus by Mr. E. C. Sanford (*American Journal of Psychology*, May, 1888).

The first method of obtaining an order of legibility of the letters consisted in measuring the distances at which they could just be read. The letters were fastened to the edge of a rotating disk, and were viewed through a square hole of 2 centimetres, in a black screen placed in front of the disk. Test-type letters of a clear bold pattern were used, the short letters being about 1.8 and the long letters about 2.2 millimetres high. The whole apparatus was mounted on runners sloping upwards from the floor at an angle of about fourteen degrees, and could be moved to any distance from the eye by pulling an endless cord.

The first method of these distance-tests consisted in showing the letters at a fixed distance for the whole alphabet, and noting the number of times each letter was rightly and wrongly named, as well as the letters with which it was liable to be confused. Another fixed distance is then chosen, and the test repeated. The result, with five subjects and the letters at distances varying by 10 centimetres from about 1.5 to 3.2 metres, was as follows, the numbers expressing the percentage of cases in which the letters were correctly read:—

<i>m</i> , 90.9	<i>v</i> , 71.0	<i>x</i> , 63.0	<i>n</i> , 46.2
<i>w</i> , 88.1	<i>k</i> , 70.9	<i>a</i> , 60.8	<i>e</i> , 46.2
<i>f</i> , 84.4	<i>b</i> , 70.4	<i>i</i> , 60.6	<i>c</i> , 45.1
<i>p</i> , 84.3	<i>y</i> , 70.4	<i>l</i> , 58.6	<i>o</i> , 44.9
<i>q</i> , 80.9	<i>h</i> , 69.9	<i>u</i> , 55.2	<i>z</i> , 34.1
<i>r</i> , 78.7	<i>d</i> , 68.3	<i>s</i> , 53.0	
<i>j</i> , 77.6	<i>g</i> , 68.2	<i>t</i> , 46.5	

These percentages are based on about three hundred answers for each letter, the preferred letter being counted as the only answer in cases of doubt between two or more letters.

From the same record we can obtain an order of the liability of the letters to confusion and the chief causes of confusion. This

order is substantially the same as the former, and would be still more closely like it were it founded on precisely the same data. The order, with the letters most likely to be confused with them, as well as the percentages of cases in which the confusion occurred, are given below:—

<i>m</i> with <i>w</i> , 52.	<i>h</i> with <i>b</i> , 51.
<i>w</i> " <i>v</i> , 53.	<i>x</i> " <i>n</i> , 19; <i>z</i> , 15.
<i>p</i> " <i>r</i> , 44.	<i>a</i> " <i>u</i> , 16; <i>n</i> , 14; <i>s</i> , 13.
<i>f</i> " <i>r</i> , 37.	<i>s</i> " <i>n</i> , 14; <i>cr</i> , 12.
<i>r</i> " <i>v</i> , 22.	<i>l</i> " <i>i</i> , 39; <i>j</i> , 36.
<i>g</i> " <i>g</i> , 30.	<i>u</i> " <i>a</i> , 18; <i>z</i> , 12.
<i>j</i> " <i>l</i> , 25; <i>f</i> , 21.	<i>i</i> " <i>l</i> , 58.
<i>v</i> " <i>r</i> , 33.	<i>t</i> " <i>i</i> , 40.
<i>y</i> " <i>p</i> , 61.	<i>n</i> " <i>a</i> , 41.
<i>d</i> " <i>ag</i> , 22.	<i>e</i> " <i>c</i> , 40.
<i>g</i> " <i>r</i> , 12; <i>t</i> , 10.	<i>z</i> " <i>e</i> , 19; <i>s</i> , 17; <i>a</i> , 16.
<i>b</i> " <i>h</i> , 45.	<i>c</i> " <i>e</i> , 34; <i>o</i> , 23.
<i>h</i> " <i>x</i> , 34.	<i>o</i> " <i>c</i> , 34; <i>e</i> , 23.

Mr. Sanford also tested the letters by setting them so far away that they could not be read, and then having the subject slowly draw them near until he could read them; in general, recording both the distance at which the subject would first hazard a guess, and the distance at which he felt confident that he had correctly read the letter. Here differences in eyesight of the subjects tested make average results meaningless, but the order for any one subject agrees fairly well with that obtained by the other test. If the letters be divided into three groups of eight, ten, and eight,—calling those in the first group good, those in the second fair, and in the third poor,—all the orders agree in making *w*, *m*, *g*, good; *b* and *x*, fair; and *z*, *o*, *c*, *s*, *e*, poor: and the balance of the evidence goes to make the good letters, *w*, *m*, *g*, *p*, *v*, *y*, *j*; the ten fair ones, *h*, *r*, *d*, *g*, *k*, *b*, *x*, *l*, *n*, *u*; and the eight poor ones, *a*, *t*, *i*, *z*, *o*, *c*, *s*, and *e*.

By an ingenious apparatus a dark box in which one of the letters was set could be illuminated for a very minute yet accurately measurable time, and the proportion of cases in which each letter could be correctly named when seen for a definite fraction of a second would again measure its relative legibility. The letters were exposed for times varying from .0013 to .004 of a second, and each letter was shown about two hundred times. A table comparable with that for distance is given below:—

<i>m</i> , 82.	<i>p</i> , 61.	<i>h</i> , 47.	<i>n</i> , 34.
<i>w</i> , 73.	<i>k</i> , 61.	<i>r</i> , 43.	<i>e</i> , 33.
<i>d</i> , 67.	<i>f</i> , 58.	<i>x</i> , 42.	<i>s</i> , 27.
<i>g</i> , 66.	<i>b</i> , 52.	<i>t</i> , 39.	<i>c</i> , 26.
<i>v</i> , 63.	<i>l</i> , 49.	<i>o</i> , 39.	<i>z</i> , 23.
<i>y</i> , 62.	<i>i</i> , 48.	<i>u</i> , 38.	
<i>j</i> , 61.	<i>g</i> , 47.	<i>a</i> , 35.	

The order of legibility by the two methods agrees very well, and yields the important conclusion that the letters read at the greatest distance are also the letters most rapidly recognized at an ordinary distance. The order for the two methods, as well as that found by Dr. Cattell by a different mode of time-measurements, are:—

Order for time, *mwdqyjpfkblighrxtouanescz*
 Order for distance, *wmqpyjfhrdgkbxlnuatizocse*
 Order for time (Cattell), *dkmqhbwpwuljtvzrofnaxyeigcs*

It so happens, that, of the eight letters most fully represented in a full font of type, three (*e*, *a*, *s*) are the very letters that all the tests agree in regarding as the worst, and six (*e*, *a*, *s*, *o*, *i*, *t*) are among those regarded as poor by two of the results.

Among the deductions formed from this study are, that the concentration of differentia is an important aid to clearness, while the lack of it leads to confusion. Thus, *b*, *d*, *p*, *g*, are all made of a straight stem and a loop, and yet are easily distinguished (except that *b* is confused with *h*); while *g* and *a*, though having few points in common with other letters, are confused with several. The group of confusables (*e*, *a*, *s*) should be differentiated, the *c* being left wide open, and some other form, such as the Greek *ε*, or an *E* with square corners, substituted for *e*: *u*, *n*, *a*, should be similarly treated; *u*, *a*, *n*, having their openings kept well open, and *a* changed perhaps to an inverted *v*; *s*, too, needs reform, and a shape

like *s* was found to have several advantages. Though not final, these observations show what letters are good, and to a certain extent why they are so; they similarly point out those that need reform, and suggest the direction in which reform should take place, and, quite as important, furnish us with a method of accurately testing the advantages of any system of letters that may be proposed.

One remark should be added. It is, that the legibility of the letter is not altogether an objective factor, but depends on the familiarity of the letters to the person reading them. Just as it has been shown that we are not as likely to name or write one number as another when told to name a number, so the letters are not equally present to our minds; and certain letters will be more often recognized or confused because we more constantly have them in mind. The same process operates against the comparison of a new form of letter with a conventional form; for the new one, not being familiar, is less likely to be recognized because more rarely present to the consciousness of the subject. Similarly, if the subject is informed that a certain letter is no longer to be shown, the very same impression that would have led him to pronounce in favor of the omitted letter will now have a different effect. In the experiments a similar result, due to the omission of a certain letter without the knowledge of the subject, was observed.

NOTES ON HYPNOTISM.¹—Dr. A. Dichas has made a detailed study of the memory in the hypnotic state, and summarizes his main conclusions somewhat as follows: (1) during the hypnotic sleep the subject remembers the experiences of his waking life as well as of previous hypnoses; (2) in hypnotism there is often an exaltation of the memory, and at times a change in its content, leading to the assumption of a foreign personality; (3) the memory of what has been going on during hypnosis is usually lost, it can often be revived by a simple suggestion, and at times the memory of a suggested hallucination may linger on, and influence the waking condition; (4) the operator can at his will have any of the acts of the hypnotic state remembered or forgotten by making this a part of a suggestion; (5) suggestion seems to be largely explicable as unconscious memory.—Dr. Cybulski has studied the power of hypnotic subjects to hypnotize themselves. He finds that such subjects strongly imagine for a minute or less that the operator commands them to go to sleep, and the desired result ensues. Furthermore, if the subject, on going to sleep, imagines himself controlled by a certain person, then, even though another sent him to sleep, he will be subject to the former, and not to the operator. These observations show the importance of the subjective element in the process of hypnotism, and indicate the method by which the subject unconsciously takes suggestions and acts upon them.—Dr. Berkhan has applied hypnotism to the amelioration of the hearing of the deaf. He tested the hearing of nine deaf boys, and, after hypnotizing them, spoke to them and had various noises made before them. The hearing of four of them was found to be improved, and the improvement is reported as still persisting after eighteen months.

HEALTH MATTERS.

Alcoholic Trance.

DR. T. D. CROTHERS of Hartford, Conn., at the recent meeting of the American Medical Association at Cincinnati, read an interesting paper entitled 'Alcoholic Trance: its Medico-Legal Relations.' In discussing this subject he said that the statements of prisoners that they had no memory or recollection of the crime, or the circumstances associated with it, are not often doubtful excuses to avoid punishment. Certain physiological conditions, supported by clinical facts, indicate beyond all question that such statements are often psychological truths.

In somnambulism the person may go about, and do many intricate acts, without consciousness or recollection of them afterwards. In epilepsy distinct periods of unconsciousness occur. Acts unusual and often violent follow, which are never remembered. In mania these memory-blanks are common, and the person is an automaton, acting without any conscious influence of the present.

¹ The reader is referred to an exhaustive review of works on hypnotism in the May number of the *American Journal of Psychology*.

These are familiar illustrations of some unknown pathological and psychological states of the brain, in which memory is suspended or cut off, and the operations of the mind go on without realization of the surroundings or the influence of experience. This is some obscure form of psychological palsy, in which the person has no recollection of his acts during this time.

From the many clinical studies of cases which have been made, the following general conclusions seem to be sustained:—

1. Alcoholic trance is not an unusual condition in inebriety. The victim is literally an automaton, and acts without memory or consciousness of passing events,—a state which may last from a few minutes to several days.

2. It is distinct from epilepsy, hysteria, or any known forms of mania, and is found associated with some unknown condition following alcoholic poisoning, continuously or at intervals.

3. This condition is probably one of brain-exhaustion, followed by a lowering of consciousness till events are no longer clearly remembered; or a suspension of nerve-force in certain directions, closely allied to paralysis of certain brain-functions: hence there are profound disturbances of brain-centres, and impaired and lessened responsibility.

Dr. Crothers has obtained the records of a large number of trance cases, and his paper gives many of these in detail.

One group of trance cases seems never to do any thing outside a natural, accustomed order of every-day life. Thus, a farmer in this state goes on with his regular work. A physician continues to visit patients, and a railroad-conductor attends to all his usual duties, without any memory of these states. A second group of trance cases seems prominent by unusual acts and thoughts. Thus, a banker in this state left his regular work, and went round delivering tracts in the lower parts of the city. A quiet, retiring man became vociferous, bold, and aggressive. A peaceful man was combative, a truthful man untruthful, and a conscientious, religious man was treacherous and sceptical. Later, these events were perfect blanks in their memory. In a third group of trance cases, some unusual line of conduct seems to grow out of the surroundings unexpectedly, or some old buried thought or conception comes to the surface. Thus, a clergyman insists on riding with the engineer on the engine. A sceptical physician takes part in a prayer-meeting. A merchant goes round threatening to kill an old schoolmaster who punished him in boyhood. A wealthy man has a new will written, disposing of his property differently every time.

In the two last groups criminal cases occur most frequently, although some very remarkable instances have been reported under the first group. In a little work entitled 'Alcoholic Somnambulism,' Professor Jerusky of St. Petersburg mentions the case of a chief of police, who was an inebriate, ordering the arrest and execution of two suspected Jews. His orders were carried out in form, but not in reality. A day later he recovered from his trance state, and had no recollection of the past: he had total amnesia of this act. Another case is cited of an officer who ordered a house burned down, on the supposition that its inmates were preparing to destroy his command. Two days later he awoke with no memory of this event, and could give no reason for the act.

In these cases the somnambulistic act was along the line of his usual work, and performed without the slightest consciousness of its nature or consequences.

The criminal trance cases may be divided into two classes, one of which seems to have no history of criminality previous to the commission of the crime. They are inebriates of active neurotic temperament, who have occupied reputable stations in life, and belong to the better classes. All crime is unusual with them, and apparently grows out of the alcoholic poisoning. The second class are the low neurotics and defectives by birth and education. They have a history of irregularities of life and conduct that seems to prepare the way for criminal acts, and probably are more subject to the trance state because of defective heredity.

All these cases in court are unrecognized. A degree of reasonable conduct up to the time of the crime, and after it, is assumed to be evidence of knowledge of the surroundings and consequences of the act. No fact of inebriety, or statement of no recollection, is thought to lessen in any way the responsibility of the act.

Clinical facts indicate that in all cases of inebriety there is a de-